November 17, 1997 F/AKC:TH

PRELIMINARY CRUISE RESULTS
NOAA SHIP Miller Freeman, CRUISE NO. MF-97-08

ECHO INTEGRATION-TRAWL SURVEY
OF WALLEYE POLLOCK IN THE EASTERN BERING SEA

Scientists from the Midwater Assessment and Conservation Engineering (MACE) program at the Alaska Fisheries Science Center (AFSC) conducted an echo integration-trawl (EIT) survey of walleye pollock (Theragra chalcogramma)on the eastern Bering Sea (EBS) shelf from Port Moller, Alaska, to the U.S./Russia convention line, aboard the NOAA ship Miller Freeman from July 16 to September 6, 1997. The cruise began and ended in Dutch Harbor, Alaska. The cruise itinerary was as follows:

Jul 7-8 Gear trials/sphere calibration in Port Susan.
Transit to Dutch Harbor.

Leg 1

Jul 16 Embark scientists in Dutch Harbor. Sphere calibration in Captain's Bay.

Jul 17-Aug 7 EIT survey of the EBS shelf. Touch and go in Dutch Harbor mid-way through leg 1 to disembark scientist.

Aug 8 Inport Dutch Harbor, Alaska.

Leg 2
Aug 9-Sep 6 Sphere calibration in Captain's Bay. EIT survey of the EBS shelf. Retrieval of oceanographic data collection ("Peggy") buoy. Sphere calibration in Makushin Bay.

Sep 6 Arrive Dutch Harbor, Alaska. End of cruise.

OBJECTIVES
The principal objective of the cruise was to collect echo integration data and midwater and demersal trawl data necessary to determine the distribution, biomass, and biological composition of walleye pollock on the eastern Bering Sea shelf. We also collected pollock target strength data for use in scaling echo integration data to estimates of absolute abundance and calibrated the 38 kHz and 120 kHz scientific acoustic systems using standard sphere techniques. In addition, we collected physical oceanographic data including temperature and salinity profiles at selected sites, and continuously

monitored sea surface parameters (e.g., temperature, salinity, light level, and productivity) and water current profiles.

Secondary objectives of the cruise were to carry out a variety of scientific projects requested by MACE and other investigators. They included the following: acoustic buoy work (leg 1, Chris Wilson 206-526-6435), bottom-typing work (legs 1 and 2, Paul von Szalay 206-526-4245), marine mammal observations (leg 1, Cyndy Tynan 206-526-4033), automated broadband identification of groundfish (leg 2, Skip Denny 360-598-4890), and vessel satellite radar measurements (legs 1 and 2, Don Montgomery 818-354-4691). Other research throughout the cruise included collecting and freezing age-1 pollock to examine their relationship with the "cold pool" (Tina Wylie-Echeverria 206-463-5514), collection of predators and prey for a pollock cannibalism study (Sam Wainright 908-932-6555), collection of pollock stomachs to examine food habits (Pat Livingston 206-526-4242), cephalopod and fish collection for a reference database on marine mammal prey (Beth Sinclair 206-526-6466), fish sample collection for a Steller Sea lion prey study (Mike Strick 206-526-4522), and genetic research on adult and age-0 pollock (Mike Canino 206-526-4174).

METHODS

Sampling Equipment:

The survey was conducted on board the NOAA ship Miller Freeman, a 66 m (216 ft) stern trawler equipped for fisheries and oceanographic research. Two Simrad(1) split-beam transducers, one operating at 38 kHz and the other at 120 kHz, were mounted on the bottom of the vessel's centerboard. With the centerboard fully extended, the transducers were 9 m below the water surface. System electronics were housed inside the vessel in a new permanent laboratory space dedicated to acoustics that replaced the portable laboratory used on previous cruises. Acoustic data were collected at both frequencies with a quantitative echo sounding system (Simrad EK500). Data from the Simrad EK500 echo sounder were stored and processed using Simrad BI500 echo integration and target strength data analysis software on a SUN workstation.

Midwater and near-bottom echosign was sampled using an Aleutian wing 30/26 trawl (AWT). The AWT is a full-mesh wing trawl constructed of nylon except for polyethylene in the codend and aft section of the body. The headrope and footrope each measured 81.7 m (268 ft). Mesh sizes tapered from 325.1 cm (128 in) in the forward section of the net to 8.9 cm (3.5 in) in the codend. The net was fitted with a 3.2 cm (1.25 in) codend liner. The AWT was fished with 82.3 m (270 ft) of 1.9 cm (0.75 in) diameter 8x19 non-rotational dandylines, and 453.6 kg (1,000-lb) or 226.8 kg (500 lb) tom weights on each side.

Fish on bottom were sampled with an 83/112 bottom trawl without roller gear. Net mesh sizes ranged from 10.2 cm (4 in) forward and 8.9 cm (3.5 in) in the codend to 3.2 cm (1.25 in) in the codend liner. Headrope and footrope lengths were 25.6 m and 34.1 m (83.9 ft and 111.9 ft), respectively, and the breastlines measured 3.4 m and 3.2 m (11.3 ft and 10.5 ft).

A Methot trawl was used to target age-0 pollock and macrozooplankton. Its mouth was a square frame measuring 2.27 m (89.5 in) on each side. Mesh size was 2 mm X 3 mm (0.08 in X 0.12 in) in the main part of the net, and 1 mm (0.04 in) in the codend. A 1.83 m (6 ft) dihedral depressor was used to generate additional downward force. A calibrated General Oceanics flow meter was attached to the mouth of the Methot trawl to determine the volume of

water filtered during trawling. The Methot trawl was attached to a single cable that was fed through a stern-mounted A-frame.

On one occasion, age-0 pollock and macrozooplankton were targeted with a Marinovich trawl. Meshes in the Marinovich trawl measured 7.6 cm (3.0 in) forward, 3.2 cm (1.3 in) in the codend, and 0.32 cm (0.125 in) in the codend liner. Headrope and footrope lengths were each 9.1 m (30 ft).

Five m2 (53.8 ft2) "Fishbuster" trawl doors [1,247.4 kg (2,750 lb)] were used with the AWT, 83/112, and Marinovich trawls. When the Marinovich trawl was towed, a 15.24 m (50 ft) long, 2.5 cm (1 in) diameter spectra restrictor line was connected between the ends of two 12.8 m (270 ft) long, 1.9 cm (0.75 in) diameter 6x19 wire ropes trailing each trawl door. Two pairs of 18.3 m (60 ft) long, 1.3 cm (0.5 in) diameter 6x19 wire ropes led aft from the restrictor line to the head and foot ropes.

Trawl depth and vertical and horizontal openings of AWT, 83/112, and Marinovich trawls were monitored with a WesMar third-wire system attached to the headrope. Trawl depths of Methot trawls were monitored with a SCANMAR depth sensor. Tow depth profiles and water temperature at depth for all trawls were obtained by attaching a small, retrievable micro bathythermograph (MBT) to the net, or, with Methot trawls, to the frame. Water temperature and salinity profile data were collected at calibration sites with a Seabird CTD system. Sea surface oceanographic data and environmental data were collected and stored on the Miller Freeman's Scientific Collection System (SCS). Ocean current profile data were collected using an ADCP system with transducers located in the vessel's centerboard.

Survey Design

The survey trackline consisted of parallel, north-south transects that began near Port Moller at about 160o 20' W longitude and proceeded northwest to the U.S./Russia convention line. Transects were spaced about 20 nmi apart and were chosen to coincide with lines of groundfish trawl stations sampled during approximately the same time period by bottom trawl survey vessels. Southern transect endpoints were either limited by Unimak Island and the Alaska Peninsula (transects 1-9) or the shelf break (transects 10-29). Northern endpoints of transects 1-16 were between 57o and 58o N and ranged from 50 m to 71 m bottom depth, while transects 17-20 ended between 58o and 62o N and ranged from 60 m to 85 m bottom depths. All were located north of significant pollock echo sign. As permission to enter the Russian Exclusive Economic Zone (EEZ) was not granted, northern extents of transects 21-29 ended at the U.S./Russia convention line. Endpoint depths along the convention line increased westward from 77 m to 251 m.

The EIT survey was conducted during daylight hours. At the start of the cruise in mid-July, daylight lasted about 17 hours (0620- 2315 ADT). By September 2 the day was reduced to about 13 1/2 hours (0845-2215 ADT). Vessel speed during survey data collection reached 12-13 knots in favorable weather, and averaged 11.6 knots. Both acoustic systems (38 kHz and 120 kHz) simultaneously collected echo integration data and split-beam target strength data. Echo integration data from the 38-kHz system were used to provide estimates of pollock abundance. Nights were dedicated to trawling, collecting target strength data, collecting bottom grabs and other data for the ocean bottom typing project, running acoustic noise tests, and testing an acoustic buoy system.

Midwater and bottom trawl hauls were made at selected locations to identify echosign and to provide biological samples. Average trawling speed was about 3 knots. Average vertical net opening for the AWT was 25 m and ranged from 18 m to 38 m. Vertical net openings averaged 3.5 and 4 for the 83/112 and Marinovich, respectively. The Methot had a fixed net opening of 2.3 m. Standard catch sorting and biological sampling procedures were used to provide weight and number by species for each haul. Pollock were sampled to determine sex, fork length, body weight, age, maturity, and ovary weight of selected females. An electronic scale was used to determine all weights taken from individual pollock specimens. Fork lengths of age-1 and older pollock were measured to the nearest cm and recorded with a Polycorder measuring device (a combination of bar code reader and hand-held computer), then downloaded into a computer. Standard lengths of age-0 pollock were measured to the nearest mm and recorded on a tally sheet, then transferred to computer. Maturities were determined by visual inspection using an eight-stage scale expressed in terms of a historical five-stage scale as follows: immature, developing 1 and 2, pre-spawning 1 and 2, spawning, and post-spawning 1 and 2. Pollock stomachs and macrozooplankton samples were preserved in 10% formalin. Samples of age-0 pollock were either preserved in formalin or frozen whole. Age-1 pollock samples, adult pollock tissue samples, and fish for the marine mammal study were frozen.

Collection of target strength data required suitable conditions (e.g., low fish density, single-species aggregations, unimodal size distribution, and calm seas) and involved passing repeatedly over an aggregation of pollock at speeds of less than 4 kts, then collecting biological data from trawl hauls made in conjunction with the acoustic data collection.

Standard sphere calibrations were made to monitor the accuracy of acoustic system performance. During calibrations, the Miller Freeman was anchored at bow and stern. We measured the acoustic properties of two different copper spheres--one for each transducer frequency--suspended below the transducer. Split-beam target strength and echo integration data were collected with the Simrad EK500 system and used to determine acoustic system gain parameters and transducer beam pattern characteristics.

PRELIMINARY RESULTS

Standard sphere calibrations:

Four standard sphere calibrations were conducted in conjunction with the cruise. No significant differences in gain parameters or transducer beam pattern characteristics were observed for the 38 kHz transducer--the primary collection system for the survey--among any of the four calibrations. The target strength (TS) gain of the 120 kHz system decreased about 1.5 dB between Port Susan, WA (water temperature 11.6o C) and Dutch Harbor, AK (water temperatures 7.4o-8.6o C). During the survey, the measured TS gain was relatively stable (23.8-24.2 dB). Decreases in TS gain with decreasing temperature have been observed with the 120 kHz system during previous calibrations.

Survey Results:

Pollock were distributed throughout the eastern Bering Sea shelf area surveyed, with the highest densities encountered west and south of St. Matthew Island (transects 18-28) and between Unimak Island and St. George Island. Vertical distribution of pollock by transect varied from east to west. East of 164o W (transects 1-7) where total acoustic return was relatively low most pollock scattering layers were observed within 10 m of

bottom and only 0-33% were in midwater. West of 164o W where total acoustic return was generally higher, pollock layered in midwater accounted for 50%-95% of the total (transects 8-29, except for 16, 21 and 23). Three different types of echosign were identified and quantified. Moderately dense near-bottom layers and echosign forming a "carpet" along the bottom were typically composed of adult pollock. Midwater layers that often formed tightly packed discrete schools during the day were usually composed of juvenile pollock <35 cm in length, typically age-1 or age-2. The third echosign type described a more complex region of the survey area along portions of transects 24-29, where juvenile pollock of more than one age class extended down into the near bottom layer.

Biological data and specimens were collected from 73 AWT hauls, 1 Marinovich haul, 10 Methot hauls and 13 bottom hauls. Oceanographic data were collected from 7 CTD casts and 97 MBT casts. Pollock dominated midwater catches made with the AWT and bottom trawl catches, accounting for 86% by weight and 70% by weight, respectively. The one Marinovich haul caught mostly jellyfish (>99% by weight), with some age-0 pollock and other species of fish larvae. Jellyfish made up 13% and 5% by weight in midwater and on bottom, respectively. Pacific herring and chum salmon were caught frequently in midwater trawls although they did not make up a large portion by weight. Most Pacific ocean perch obtained during the survey came from a single haul (haul 50) that also caught northern rockfish. In addition to pollock and jellyfish, bottom trawl catches contained numerous yellowfin sole and Pacific cod.

Pollock ranged in length from 10 to 73 cm with a major mode at 16 cm and minor modes at 27 and 40 cm. East of 170o W longitude, pollock numbers were dominated by the 1996 year class (age 1). West of 170o W longitude, the 1996 year class was again the most numerous, followed by the 1995 (age 2) and 1992 (age 5) year classes. The average length of adult pollock (>35 cm) captured in trawl hauls ranged from 43-53 cm east of the Pribilofs, but decreased to 39-47 cm west of the Pribilofs reflecting increased presence of the 1992 year class. Average length in trawl hauls among pollock 35 cm and smaller showed that age 2 fish were mainly encountered in the northwest corner of the survey area while age 1's were distributed across the shelf.

Biomass of pollock in midwater (from near the surface to 3 m from the bottom) was estimated at 2.6 million tons with 0.8 million tons east of 170o W longitude and 1.8 million tons west of 170o W longitude. The 1992 year class accounted for 0.9 million tons and the 1996 and 1995 juvenile year classes made up 0.4 million tons each. Although the estimated biomass for summer 1997 (2.6 million tons) was close to that from summer 1996 (2.3 million tons), the estimated numbers of fish in 1997, 18.7 billion--of which the 1996 year class totaled 12.4 billion--contrasted with only 6.5 billion fish in 1996.

SCIENTIFIC PERSONNEL

The principal investigator was Neal Williamson (206) 526-6417, AFSC, Seattle, WA.

Gear Trials (July 7-8)

Name	Sex/Nationality	Position	Organization
Daniel Twohig	M/USA	Instrument Chief	MACE
Chris Wilson	M/USA	Fish. Biologist	MACE
Mike Guttormsen	M/USA	Fish. Biologist	MACE
Steve de Blois	M/USA	Fish. Biologist	MACE

Bob McConnaughey M/USA Fish. Biologist RACE,GF
Paul von Szalay M/USA Graduate Student UW
Karl Rhynas M/Canada Electronics Tech. QTC

Leg 1 (July 16-August 7)
Name Sex/Nationality Position Organization

Jim Traynor M/USA Chief Scientist MACE
Daniel Twohig M/USA Instrument Chief MACE
Denise McKelvey F/USA Fish. Biologist MACE
Mike Guttormsen M/USA Fish. Biologist MACE
Kevin Landgraf M/USA Fish. Biologist MACE
Paul von Szalay M/USA Graduate Student UW
Beth Jewell F/USA Teacher at Sea NOAA
Cyndy Tynan F/USA Biologist NOAA,UW
Richard Rowlett M/USA Biologist NMML
Bob Pitman M/USA Biologist SWFSC
Chris Wilson M/USA Fish. Biologist MACE(Jul 16-22)

Leg 2 (August 9-Sept. 6)
Name Sex/Nationality Position Organization

Neal Williamson M/USA Chief Scientist MACE
Daniel Twohig M/USA Instrument Chief MACE
Steve de Blois M/USA Fish. Biologist MACE
Kevin Landgraf M/USA Fish. Biologist MACE
Taina Honkalehto F/USA Fish. Biologist MACE
Mikhail Stepanenko M/Russia Fish. Biologist TINRO
Alexander Nikolayev M/Russia Acoustician TINRO
Skip Denny M/USA Acoustician SFS
Sara Pautsky F/USA Student WWU

MACE - Midwater Assessment and Conservation Engineering, AFSC, Seattle, WA
NMML - National Marine Mammal Laboratory, AFSC, Seattle WA
NOAA - National Oceanographic and Atmospheric Administration
QTC - Quester Tangent Corporation, Sidney, BC, Canada.
RACE,GF- Resource Assessment and Conservation Engineering,
Bering Sea Groundfish Group, AFSC, Seattle, WA
SFS - Scientific Fishery Systems, Inc., Anchorage, AK.
SWFSC - Southwest Fisheries Science Center, San Diego, CA.
TINRO - Pacific Research Institute of Fisheries and Oceanography Vladivostok, Russia
UW - University of Washington, Seattle, WA
WWU - Western Washington University, Bellingham, WA

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1. Reference to trade names or commercial firms does not constitute U.S. government endorsement.